

## Fire in the *Banksia* woodlands of the Swan Coastal Plain

A J M Hopkins<sup>1</sup> & E A Griffin<sup>2</sup>

<sup>1</sup>Department of Conservation and Land Management, PO Box 51, Wanneroo WA 6065

<sup>2</sup>47 MacMillan Street, Victoria Park WA 6100

### Introduction

As is the case for most remnants of native vegetation in south western Australia, fire is an important management consideration for the *Banksia* woodlands of the Swan Coastal Plain. The proximity of these woodlands to the major urban and semi-rural developments within the State ensures that issues of fire protection have considerable prominence. Yet despite the ease of access for study purposes and the importance of effective fire management of these woodlands, relatively little is known of their fire ecology. In this paper we review briefly relevant information on this aspect and seek to provide guidelines for future management and research.

### Historical burning

Judging by the records of observations compiled by Hallam (1979), there were concentrations of aboriginal people around the estuaries of the coastal plain from Moore River to Albany and perhaps further afield. These people did use fire: charcoal associated with artifacts in the Upper Swan archaeological deposit gave dates of almost 40 000 years (Pearce & Barbeti 1981).

The establishment of the Swan colony in 1829 would almost certainly have led to changes in frequency, intensity, seasonality, and spatial distribution of fires (regime, *sensu* Gill 1975, Hopkins 1985a). The nature of these changes can only be speculated although it is probable that useful information exists in various historical accounts. Some fire records have been kept by the Wanneroo District Office of the Department of Conservation and Land Management over the past 30 years; these show that there have been some fuel reduction burns, mainly in spring, and some wildfires, mainly in autumn and recurring at intervals of about 6-8 years.

### Fire fuels

Burrows & McCaw (in press) have constructed fuel accumulation curves on the basis of extensive sampling of the *Banksia* woodlands in the Wanneroo area. After c 6 years the total available fuel stabilized at between 6 and 8 tonnes ha<sup>-1</sup> oven dry weight. These levels of fire fuels seem surprisingly low especially when compared with total above-ground biomass of *Banksia ornata* woodland at Keith, South Australia (460 mm annual rainfall) (Jones *et al* 1969). The curves, together with information on fire behaviour in these fuel types, suggest that repeated fuel reduction burning on a broad acre basis would be of limited practical value (Burrows & McCaw in press).

### Effects of fire on plants

To provide this overview on the effects of fire regimes on the *Banksia* woodlands, we have focussed on selected aspects of the biology of the component species. This has enabled us to piece together the results of studies of fire on *Eucalyptus-Banksia-Allocasuarina* woodland at King's Park (Baird 1977), on *Banksia* woodlands at Mooliabeenee east of Gingin (R J Hobbs unpubl data) as well as studies on other aspects of *Banksia* woodlands (eg Dodd *et al* 1984).

The plant communities that now make up the *Banksia* woodlands of the Swan Coastal Plain contain very few long-lived perennial plant species that regenerate only from seed following 100% crown scorch (Table 1). Only 6 of the 13 species identified are in the most vulnerable category (Hopkins 1985b), being fire sensitive and having seed storage on the plant in bradyspores. This feature, together with the general observation that significant areas of *Banksia* woodlands apparently in good condition still exist, indicates that the present-day plant communities comprising these woodlands must be tolerant of a wide range of fire regimes.

Generalizations about the impact of recurrent fire on the *Banksia* woodland communities could be developed by collecting data on the time it takes for species in Table 1 from germination of seed to production of sufficient, viable seed to permit population replacement in the event of a further fire. In the absence of detailed data, a rough guide of 2.5 to 3 times the time from germination to first flowering can be applied as a minimum between-fire interval if local extinctions are to be avoided (*cf* Gill & McMahon 1986).

There are no data from these *Banksia* woodlands that indicate best season of burn for conservation but the study of *Banksia burdetti* at Watheroo National Park by Lamont & Barker (1988) may be indicative. That study shows best seed release, germination and establishment after a hot fire in late summer/autumn.

Season of burn also has some bearing on fire intensity. Burrows (1985) showed that the extent of death of stems of *Banksia grandis* in the jarrah forest was a direct function of fire intensity: hotter fires kill more stems. A similar effect could be expected for *Banksia* spp on the coastal plain.

A conspicuous, complicating factor in the process of developing management guidelines is the likely invasion of burnt areas by weeds. As Keighery (this volume) points out, weeds are commonly associated with disturbed sites including many with a history of recurrent fire (see also Baird 1977, Bridgewater &

Backshall 1981). Not only does weed invasion lead to loss of nature conservation values, it also can lead to a vicious spiral of degeneration of the vegetation through recurrent burning because the presence of weeds alters the characteristics of the fire fuel bed, engendering an increase in flammability.

### Fire and animals

The other important interaction associated with fire is between plants and animals. Whelan & Main (1979) showed how grasshoppers can modify regenerating vegetation by grazing selectively on seedlings and presumably on other types of shoots. The impact of herbivores is particularly acute after small and/or patchy burns.

Bamford (1986) also looked at effects of fire on invertebrates but more in terms of their role as a food resource for the vertebrates. Bamford's study area was east of Gingin but supported *Banksia* woodlands similar to those of the Swan Coastal Plain. He found that a spring fire reduced invertebrate numbers more than an autumn fire and suggested that the impact would be greatest on diurnal, terrestrial invertebrates and that this would have particular repercussions for the reptiles. This was not obvious in the trapping results; indeed the vertebrate fauna generally appeared to have coped quite well with the historical fires of the study area and the experimental fires. However, Bamford (1986) did observe that there had been some extinctions (three species of birds and perhaps some mammals) from the Swan Coastal Plain north of Perth which may be a consequence of the frequent, intense and extensive fires associated with European settlement (see also Bamford & Dunlop 1984).

The interaction between fires and weeds is also relevant when considering fauna. How & Dell (this volume) observe a decline in open area feeding reptiles with the invasion of the open areas by weeds. As noted above, weed invasion can be promoted by recurrent burning.

### Concluding remarks

Because of the extensive clearing and disturbance of the *Banksia* woodlands of the Swan Coastal Plain these woodlands are now at a point where effective conservation and management is critical. Despite their proximity to Perth, these *Banksia* woodlands have been neglected scientifically; this applies as much to the issue of fire - its effects and its use in management - as to the many other important aspects of their biology. There is a real need to redress this situation.

In respect of fire alone, the present-day plant and animal communities of the *Banksia* woodlands appear to be relatively robust. They contain few plant species that we could describe as vulnerable. The fauna has also been shown to tolerate a certain regime of fire. We have, of course, no real insight into the extent of and reasons for disappearances of species from the Swan Coastal Plain in historical times. This apparent robustness is no justification for continuation of *laissez-faire* management; further species losses and degeneration are likely consequences of such an approach.

It would be a relatively simple matter to develop fire management guidelines for these *Banksia* woodlands starting with the gathering of data on rates of regeneration of vulnerable plant species provided that we are prepared to accept the rule of thumb suggested here as the basis for those guidelines. However, such an approach does not take into account the important interaction that we have identified here - that is the interac-

tion between fire (or any other form of disturbance) and weed invasion. Fire has the potential to promote weed invasion which in turn leads to increases in flammability of the vegetation and the loss of nature conservation values. This fire-weed interaction is probably the most important issue to be taken into account in the development of any fire management strategies in the future.

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Table 1

Long-lived perennial plant species which occur in *Banksia* woodland communities on the Swan Coastal Plain (from the list compiled by Griffin & Dodd for this symposium) and which are killed by fire causing 100% canopy scorch and which regenerate only from seed.

Species with seed storage on plant	Species with seed storage in soil
<i>Banksia prionotes</i>	<i>Adenanthos cygnorum</i>
<i>Dryandra sessilis</i>	<i>Astroloma xerophyllum</i>
<i>Hakea trifurcata</i>	<i>Leucopogon striatus</i>
<i>Hakea obliqua</i>	<i>Leucopogon cordatum</i>
<i>Beaufortia elegans</i>	<i>Lysinema ciliatum</i>
<i>Beaufortia squarrosa</i>	<i>Astroloma heterophyllum</i>
	<i>Acacia pulchella</i>